Rohé (Geo. H.)

Compliments of
Dr. Rohé.

SOME POINTS

ON THE

Administration of Anesthetics,

By GEORGE H. ROHÉ, M. D.
Professor of Hygiene and Clinical Dermatology, College of Physicians and Surgeons, Baltimore.

BALTIMORE:
Office of the Medical Chronicle.

THE MEDICAL CHRONICLE,

EDITED BY GEORGE H. ROHÉ, M. D.

THE MEDICAL CHRONICLE is a Monthly Medical Journal, published in the joint interest of the Medical Profession and of the editor.

It will contain such original papers, lectures and clinical reports as appear to be of most interest and value to the Practitioner.

The latest advances in the scientific and practical branches of Medicine and Surgery will be presented in an intelligible shape and devoid of useless detail and verbiage.

The editorial comments will be brief and plain. All measures affecting the interests of the profession will be discussed from an independent standpoint. Personalities will be rigidly excluded.

If you wish to subscribe, *send your address and One Dollar to* Dr. George H. Rohé, 95 Park Avenue, Baltimore.

SOME POINTS CONCERNING

Anesthetics and their Administration.

A LECTURE

By GEO. H. ROHÉ, M. D.,
Professor of Hygiene and Clinical Dermatology, College of Physicians and Surgeons, Baltimore.

I. HISTORICAL OBSERVATIONS.

The first attempts at procuring anesthesia during surgical operations by means of inhalation, are recorded by Theodoric of Cervia, Gilbert and Guy de Chauliac. A *confectio soporis* is mentioned by the first named author, which appears to have consisted of a strong decoction of opium, conium, hyoscyamus, mandragora, lactucarium and other vegetable narcotics. With this a sponge was saturated, and the patient allowed to breathe the vapor until a certain degree of stupefaction resulted. These records date from the 13th century. This soporific appears to have been the invention of one *Master Nicholas*, the President of the Medical School of Salerno in the twelfth century. Porta speaks (in the 17th century) of an ethereal substance which produced sleep and insensibility to pain during surgical operations.

About the year 1800, Davy made known his observations on the intoxicating effects of the inhalation of nitrous oxide, or as it was generally termed, "laughing gas." These observations, and the expressed opinion of Davy, that by means of this gas surgical operations could be rendered painless, caused intense excitement throughout Europe, and many experiments were made to test the effects of the compound. It was soon demonstrated however that the effects of the gas were too evanescent to be of much service as a surgical anesthetic. The search for such an agent was thereafter generally conconsidered a hopeless one, and only ten years previous to the demonstration of the anesthetic effects of ether, by an American chemist in the city of Boston, the great Velpeau declared in his treatise on Ope-

rative Surgery: "The attempt to destroy all pain during surgical operations is a chimera, which it is hardly permissible to follow at the present day." Velpeau was not the first who discovered that even seeming impossibilities become possible as experience becomes greater and knowledge advances.

What a scene of intense anxiety must have been that presented in the surgical amphitheatre of the Massachusetts General Hospital on the 17th of October, 1846, when Warren performed the first grave surgical operation under ether narcosis! The operation consisted in the removal of a large tumor of the neck. Try and imagine, in addition to the danger from hemorrhage, or injury of the pneumogastric nerve, the effect of an untried agent by which the patient was brought into a condition of deep narcosis, which must have appeared to the surgeon and his audience, itself a condition analogous to death! It is no wonder that at the successful termination of the operation Warren was saluted by a storm of applause that shook the building to its foundations? At this day, when this spectacle has become familiar through frequent repetition, one can form no adequate conception of the excitement under which that class of students, the invited physicians, and the operator and his assistants labored. The news spread throughout the world, and ether was hailed by surgeons and their patients as the greatest boon vouchsafed to suffering humanity. For a while ether retained this supremacy, but was soon supplanted in favor by its more popular rival, chloroform, which was introduced by Sir James Y. Simpson, the great obstetrician, who gave an account of his observations and experiments on chloroform narcosis to the medical society of Edinburg less than fifteen months after the first successful use of ether as an anesthetic. This was a more agreeable and more rapidly-acting agent than ether, and rapidly superseded the latter anæsthetic. But this rose was not without its thorn, for within a year after the researches of Simpson had been published, six deaths during chloroform anesthesia had occurred in England and France, and by the end of 1849, two years after its introduction, the number slain by chloroform was fifteen.

Under all this excitement two cities remained true to the claims of ether as an anesthetic, and were not carried away by the excitement for chloroform. These were Lyons, in France, and Boston, in this country. Only few surgeons in these two cities gave up the safer an-

esthetic for the more agreeable and convenient, but more deadly agent.

The adjective "deadly" may be objected to by those who are unfamiliar with the ghastly mortality from this agent. Facts are the only things wanted in this enquiry, and I shall presently refer to the record of full, authenticated deaths from chloroform administered for surgical purposes.

In 1867, Dr. B. W. Richardson of London, introduced a new anesthetic to the profession. This compound is called Bichloride of Methylene, or Chloromethyl. So far as I have been able to ascertain only one prominent surgeon, Spencer Wells, uses this anesthetic, and expresses himself as thoroughly satisfied with its action. He has seen no dangerous effects from its use. Between 1870 and 1875, however, *nine* deaths were reported from this anesthetic in England alone. In addition to these several others have deen reported where the bichloride of methylene was mixed with ether.

In 1840, Mr. Nunnely of Leeds, experimented with hydrobromic ether, since called Bromide of Ethyl. His experiments attracted little attention however, until in 1878, Dr. Laurence Turnbull of Philadelphia read a paper before the Pennsylvania State Medical Society upon its apparent advantages as an anesthetic. Dr. R. J. Levis of the same city took it up, and in January, 1880, published the results of his observations during the preceding year. Within two months Dr. J. Marion Sims had reported one death, the first and only instance in which he had used it, and within six months another death under its influence was reported by its foremost defender, Levis. Thus, "the best anesthetic known to the profession," (Levis), was buried, it is to be hoped, never again to be resurrected. In the course of a discussion before the New York Academy of Medicine on the fatal case of Dr. Sims, Dr. E. R. Squibb made the following pertinent remarks:

"I think, as a chemical principle, those ethers are the least dangerous which are most simple, and which yield by decomposition, innocuous elements. Nitrous oxide is decomposable into innocuous elements, so is the oxide of ethyl. In the bromide of ethyl (not really an ethyl), the oxygen is replaced by bromine to the extent of 73 per cent., the other 27 per cent. being the ethyl. Now the simplest anesthetics are the easiest borne. Bromine is an irritant poison. Bromide of ethyl is an easily decomposed compound. If, therefore, it be

decomposed, and its irritant element the 73 per cent. of bromine goes into the system, it is easy to understand that grave effects might be produced. An analogy exists in the case of chloroform, which contains 89 per cent. of chlorine, two atoms of which in toxic effect are not equal to one of bromine We can illustrate still further by supposing an arsenite of ethyl. If this argument have any value, we can, I think, understand why compound ethers are most dangerous, a fact that agrees with Richardson's observations."

II. What Anesthetic should be Used?

Fifteen years ago I stood by the bedside of a boy with uremic convulsions following scarlet fever. During the convulsive attacks, I administered inhalations of chloroform, with the effect of always promptly relieving spasmodic action. I kept my finger on the pulse and watched as closely as I could the character of the respiration. Owing to the convulsions, the respiratory rhythm was of course irregular. While giving him the chloroform during one of the attacks, I uddenly lost the pulse at the wrist, saw him become relaxed and deathly pale. I threw away the handkerchief from which I had given the chloroform, compressed the thorax forcibly and attempted to restore the natural respiratory movements by alternately compressing the chest, and raising the chest walls with the hands under the ribs. All efforts were useless however, and I soon came to the sad conclusion that the patient was beyond human help.

Thus, at the outset of my student-life I was brought face to face with probably the most terrible accident that can befall a surgeon. I was accused by the patient's family of having caused his death. I have tried to divest myself of the belief that the boy died from the effects of the chloroform. I have told myself over and over that the poison circulating in his blood, and which was the cause of the convulsions was also responsible for his death, and I hope it was; but, the more I see or read of the effects of chloroform, the more am I convinced that the poor boy's relatives were correct in their inference.

Standing by that bedside, at an impressionable age, I imbibed a horror of chloroform of which I have never been able to divest myself. I have since then given it frequently, but always under a spoken or implied protest. I have tried to learn in what its fatal action consisted, and if it could not possibly be avoided. Instead of losing my

aversion for it, this has grown stronger with each year until I have become a radical so far as chloroform is concerned. If there is one thing in the world that I would irrevocably destroy had I the power, it is chloroform, because I firmly believe that the good it has done, and is capable of doing is more than counterbalanced by its fatal and pernicious effects in so many recorded instances.

With the experience just related ever fresh in my mind, I have closely studied the literature of anesthesia during the past ten years. The result of that study is, that there are before the profession to-day, only two anesthetics having any claim in a discussion of the superiority of one or the other of such agents. These are, as you well know, Ether and Chloroform. Which shall we use?

I assert, on the basis of large clinical and experimental evidence, that ether is the safer anesthetic of the two; that, if properly administered, it is equally as effectual as chloroform, and that if these two propositions can be established, chloroform should be entirely supplanted by ether in all surgical operations.

Let us examine the evidence in detail.

Without going over all the experiments and theories based upon them, which have been the results of the numerous investigations into the action of anesthetic agents, I will only refer to a few of the most recent, and presumably the least inaccurate.

The psychical effects of chloroform and ether are so familiar, that it is unnecessary to describe them here. It will be sufficient to state that the phenomena of anesthetics are generally divided into two stages: The stage of excitement and that of total loss of sensibility.

The effects are conveniently divided into those on the circulation, respiration and the nervous system.

The pulse is increased in the beginning of chloroform narcosis, and later becomes slow and soft. Sphygmographic tracings made during chloroform narcosis show marked monocrotism, and rounding of the apex of the curve. This effect seems to indicate that the muscular contractility of the vessels is lost and that the return to the normal calibre is due alone to the elasticity of the elastic coats of the artery. Hence we may conclude that the vaso-motor nerves are paralyzed during deep chloroform narcosis. The anacrotism can only be due to depressed innervation of the circulatory system.

The congestion of the skin and redness of the lips, present in the

first stage of chloroform anesthesia, gradually disappear leaving the patient pallid ; and if the respiration becomes irregular, bluish.

There is usually a slight decrease of temperature during the narcosis, amounting on the average to about 1°Fahr. In most cases the temperature returns to the normal within a short time. The breathing is generally irregular, spasmodic, sighing, or shallow and increased in frequency. Sometimes the tongue falls back and the larynx is closed by the epiglottis, causing alarming symptoms of apnœa. During the deep stage of narcosis there is generally snoring respiration. There is frequently cough, especially at the beginning of the inhalation. The pupil at first dilates, and as total unconsciousness and insensibility approach contracts to one-half or less of its former size. A rapid dilatation during deep narcosis is generally coincident with dangerous symptoms, such as failure of the circulation. During deep anesthesia there is want of association of the ocular muscles on the two sides.

There is usually vomiting in chloroform narcosis.

Owing to peripheral stimulation of the nerves, the secretions of the salivary and bronchial glands are increased.

The sensibility of the cornea persists longest. Operations about the extremities can be performed painlessly, while strong reflex symptoms persist when the conjunctivæ are touched.

EFFECTS OF CHLOROFORM ON THE BLOOD, RESPIRATION AND OTHER FUNCTIONS.

Chloroform destroys the red blood corpuscles and sets the hemoglobin free from its combinations. Some authors have considered that the effects of the chloroform depended on this lytic action on the blood constituents ; believing that blood so changed is incapable of carrying on the proper nutrition of the system. Others have found that chloroform produces a paralysis of muscular fibre when directly applied to it. It is however not demonstrated that the blood corpuscles in an individual anesthetised with chloroform undergo that destruction which takes place when chloroform is added to the blood outside the body. McQuillan has shown, in fact, that chloroform, ether or nitrous oxide added in vapor to the blood out of the body does not produce that destruction or change of form of the corpuscles noticed by Boettcher, Hermann and others.

Bernstein opened the aorta of frogs and after the blood had ceased to flow, washed out the vessels with a ½ per cent. solution of chloride

of sodium. Chloroform administered to frogs treated in this manner still produced its effects, showing a direct action of the chloroform on the nervous system.

From further experiments of Bernstein and of Schenck, it appears that this effect takes place on the nerve-centres and not on the nerves at their periphery or in their continuity.

Bernstein found that if the spinal cord of the frog was divided between the third and fourth vertebræ and the frog chloroformed, the lower extremities still re-acted to impressions, while above the point of section reflex action had disappeared. Taking into account the peculiarity of the spinal circulation in the frog, this throws much light on the action of the anesthetic. This arrangement is as follows: The cerebral and spinal blood supply enters the spinal canal at the upper portion of the medulla oblongata, and forming a vascular circle with the vessels of the opposite side, the vessels go upward to the brain and downward supplying the cord. In section of the cord, at the third vertebra, the blood supply is cut off from the cord below this point. The general blood-supply to the tissues (including, of course, the nerves) is however not interfered with. But none of the chloroform-laden blood reaches the motor and sensory centres in the spinal cord, and so reflex action in the tract below the point of section is not abrogated. This is a very important observation, inasmuch as it demonstrates that the paralysis of sensation in chloroform narcosis has its seat in the spinal cord and not in the peripheral terminations of the nerves.

Other experiments appear to show that the nerve fibres are not affected by the anesthetic, but that the ganglion-cells are the structures influenced, and that the centres of sensation are earlier affected than those of motion. Thus the heart and respiratory muscles continue acting after all reflex phenomena have ceased.

Binz has shown that narcotic substances such as ether, chloroform, morphia and chloral hydrate possess the power to produce a coagulation of nervous substance. Volatile anesthetics also dissolve protagon, and Hermann seeks in this action an explanation of their effects. But even if it were proven that such is the case, the explanation would be defective.

Chloroform paralyses the vaso-motor centres and so lowers blood pressure. This seems to be clearly shown by the experiments of

Scheinesson, Koch, Bowditch and Minot. There also seems to be a direct action of the chloroform on the heart.

The reduction in temperature during chloroform narcosis is positive and dependent upon diminished heat-production, not increased heat radiation. The decrease of heat-production is probably due to diminished tissue-change. Chloroform acts directly on the respiratory centre and not on the terminations of the vagi which supply the lungs.

But while it is now known that the direct action of the respiratory centre in the medulla is automatic and not reflex, the fact remains that stimulation or section of the vagi materially modifies the character of the respiration.

The pupil is first dilated and afterwards contracted in chloroform anesthesia. Raehlmann and Witkowski conclude from the results of experiments and the observations of others that dilatation of the pupil is not merely dependent upon the influence of light, but also upon sensory and emotional impressions. Hence an irritation or stimulation of any sensory nerve produces dilatation of the pupil, but in deep chloroform narcosis and in natural sleep the pupil remains contracted because sensation has been abolished.

One of the most annoying and at times dangerous complications of chloroform anesthesia is vomiting. In at least one-third of all cases vomiting occurs, *during* the anesthetic stage; the patient generally awakes and the operation is interrupted.

The vomiting may become a dangerous complication, as vomited matter may pass into the trachea and cause death by asphyxia. In protracted anesthesia vomiting is rarely absent. Psychical excitement, sometimes amounting to actual mania, may remain after awaking from the narcosis.

Irregularities and interruptions of the respiration not unfrequently occur during the anesthesia. In the beginning of the inhalation, the breathing may be interrupted by reflex irritation of the laryngeal nerves, but the most dangerous symptoms occur later, when complete relaxation has been produced by the anesthetic. The tongue drops back and closes the glottis, giving rise to symptoms of asphyxia. These symptoms are in general easily removed by drawing forward the tongue and resorting to artificial respiration.

The most alarming symptoms occur, however, in connexion with the circulatory system. It is here where the grave dangers of chlo-

roform narcosis lie. The heart ceases to act, the skin of the patient becomes deathly pale. There are a few quiet inspirations and expirations, the eyes open with widely dilated pupils, and all is over. There is no accident in surgery before which the surgeon stands so entirely helpless as in heart failure during chloroform narcosis. There is no means to avert it, and no probably certain remedy after it has come on.

To sum up then the experimental evidence: the experiments of Bernstein, Schenk and others appear to show that the effects of anesthetics are not due to any alteration of the blood, but to their direct action on the nervous centres. Elaborate experiments by these observers, show that the effects are not produced on the nerves in their continuity or at their peripheral terminations, but on the centres. Thus, the disturbing effects of chloroform and ether on the respiration are not due—except in the beginning of the inhalation—to irritation of the pneumogastric nerves, and hence reflex contractions of the respiratory muscles, but to a direct influence upon the respiratory centre in the medulla oblongata. The same experimenters have shown that the depressing effect of chloroform on the heart's action is due to an impression upon the circulatory centre; together with probably a paralyzing action upon the musculo-motor ganglia in the heart itself. The paralysis of sensation in anesthesia has been shown to be the result of the action of the anesthetic upon the sensory ganglia in the spinal cord, and not upon the nerve fibres.

In experiments on animals, it has been conclusively demonstrated that chloroform exercises a depressing effect upon the vaso-motor centre, and so reduces the blood-pressure. Schiff, Scheinesson, Koch, Bowditch and Minot, and the committee on anesthetics of the British Medical Association, agree pretty closely on these points. Ether does not have such an effect on the blood-pressure.

The "Chloroform Committee" of the British Medical Association, made a report of their observations in 1879, from which I quote the following extract:

The committee refer to the familiar physiological experiment in which frogs are anesthetised to respiratory paralysis, then exposing the heart by cutting the sternum in the middle line and watching the effect of a further supply of the anesthetic on the heart. With chloroform the heart became rapidly weaker and soon ceased beating

altogether. With ether, on the contrary, the heart continued beating vigorously for a considerable time.

"With a similar view," the committee says, "methods were devised for warm blooded animals. Rabbits were first used, and afterwards dogs. The animal was anesthetised, then the trachea was opened, a tube introduced, and artificial respiration begun by means of a double-acting pump (one cylinder forcing air in and another sucking it out). By an arrangement of india-rubber tubes, chloroform or any other anesthetic could be introduced in the circuit between the pump and the trachea. It is to be understood that in these experiments, the air passed into the animal's lungs was saturated with the vapor of the substance used. After artificial respiration had been set going, the heart was exposed by an incision in the middle line, which was carried by a pair of blunt scissors or bone forceps through the ensiform cartilage and lower part of the sternum. This was effected generally with no serious bleeding. It soon became apparent that when chloroform is given in this way, there is at once a most serious effect on the heart: the right ventricle almost immediately begins to distend, and the heart presently stops, with the right ventricle engorged with blood. The heart had often in the case of rabbits, virtually come to a stand-still within a minute of the introduction of chloroform by the method described. The contrast was most striking when ether was used instead of chloroform, the other steps in the experiment being the same. Ether may be given for an indefinite period without interfering with the action of the heart. We kept up artificial respiration with ether in the circuit for an hour, not including twenty minutes occupied in producing anesthesia, and at the end of that time the exposed heart was beating as vigorously as at first."

The final conclusions of the committee are summarised as follows:

The chief dangers from chloroform, are:

(1) Sudden stoppage of the heart.
(2) Reduction of the blood-pressure.
(3) Alteration of the pulse-respiration ratio, and
(4) Sudden cessation of the respiration.

"The danger with ether approaches from the pulmonary rather than from the cardiac side —so that by establishing artificial respiration we have a means of warding off death."

I will rapidly run over the clinical evidence of the dangerous character of chloroform anesthesia. In man, as shown by sphygmographic tracings made by Kappeler in twenty-five operations during which only a small quantity of blood was lost, there was a uniform decrease of blood-pressure. The decrease was not uniform in ether narcosis. Anomalies of respiration, stertor, superficial breathing, sudden stoppage of the breathing, are more frequent in chloroform than in ether anesthesia. Cardiac syncope, as indicated by fluttering or inappreciable pulse, pallor, sighing respiration and cessation of hemorrhage from any wound are not unfrequent concomitants in chloroform anesthesia. Where ether is given these alarming symptoms are rarely or never seen.

The mortality from chloroform is immensely larger than that from ether. The discrepancy is not explained alone by the greater number of instances in which chloroform is used. Thus, taking the record of this city. In 1874, Dr. Jas. H. Butler reported in the *Baltimore Phys. and Surg.*, June, 1874, a death under the administration of chloroform for reduction of dislocation. In the same journal is another death from the same cause, reported from Slanesville, W. Va. In 1877, a negro man living in that section of Baltimore known as "old town," died under chloroform. Mention was made of this case in the daily papers, but I believe it was not reported in a medical journal. The case before related makes the third in this city within 15 years, of which I have definite knowledge. It is currently rumored that there are several others.

In the *British Medical Journal* for Dec. 18, 1880, is published a table of all reported deaths from chloroform, ether, mixed vapors and bichloride of methylene, occurring in the United Kingdom of Great Britain from 1870-1880. The figures are as follows:

Chloroform caused - - -	120 deaths.
Ether " - - - -	11 "
Ether and Chloroform - - - -	7 "
Bichloride of Methylene caused - -	10 "

During the last eight years ether has largely supplanted chloroform in the large hospitals of London and Dublin, and yet the disproportion is so enormous as to amount to a definite answer to the question: Is chloroform more dangerous than ether?

Lyman (*Artificial Anesthesia and Anesthetics, New York*, 1881,)

gives a summary of all cases of death from chloroform or ether reported down to the beginning of the year 1881. From this it appears that 392 cases had been reported either in medical journals or newspapers down to January 8, 1881. A case is added, probably privately reported to the author, in March, 1881. My own case and the one occurring in this city in 1877 are not included in Dr. Lyman's. These three cases raise the total deaths, up to January 1881, to 395.

In the *British Medical Journal*, Feb. 15, 1882, Dr. E. H. Jacobs gives a table of deaths from anesthetics in the British Isles, from January, 1881 to February, 1882. This includes nine deaths from chloroform, which added to the 395 above reported makes a total of 404. In this total the cases which have been reported in this country and on the continent of Europe since 1880, are not given.

The number of cases of death from ether reported by Lyman to March 1881 is twenty-seven. To this is to be added one reported by Dr. Dandridge of Cincinnati (*Lancet & Clinic*, Oct. 30, 1880,) one by Roberts, Philadelphia, (*Med. Times*, June 4, 1881) and four by Jacobs, (*Brit. Med. Jour.* February, 18, 1882). Of the latter four, two died from obstructions in the larynx, (vomited matter and blood). In two of those reported in Lyman's work, death resulted from a similar cause.

This makes thirty-three as the entire number of immediate deaths from ether reported since its first introduction. A small number (five) of cases is reported in which death occurred from one and a half to forty hours after the administration of ether. In one of these cases also vomited matters were found in the trachea causing asphyxia. It has recently been stated, notably by Emmett and Reeve, that ether is exceedingly dangerous in those forms of chronic kidney disease which manifest themselves by albuminuria. I question whether the danger is as great as represented, especially by Emmett.

But, as before stated, statistics of the mortality from either chloroform or ether are of little value except as a not very reliable general guide. Dr. Lyman, in the excellent work above quoted, makes this very clear when he says: "Occasionally some elderly physician alludes in a cautious manner to a case of which he was cognisant, long years ago, in a remote quarter of the earth. In some such way it has been published that in Cincinnati and its adjacent territory not less than twenty-five deaths from chloroform had occurred since the introduction of that anesthetic."

Through similar cautious admissions, I have recently learned of two cases which had occurred during the late war and had never found their way into the records of the Surgeon General's office as deaths from chloroform.

The discrepancy between the deaths from the two anesthetics is too great to be explained on any other ground than the greater relative safety of ether.

One word as to the use of chloroform in children, and in obstetric practice. In Lyman's table, of 255 deaths where the age was recorded, 19 were ten years or under. Dr. B. E. Cotting, a physician of high standing in Boston, reported a few years ago, a case of obstetrics, in which there can be little doubt that the cause of death was the chloroform. Dr. W. T. Lusk reports in the *Gynecological Transactions* for 1877, three cases in which alarming symptoms occurred during the administration of chloroform in labor. Only the most prompt measures averted the fatal issue. Dr. Lusk pertinently asks whether these histories can regarded as isolated ones?

Again it is said that in the aged, chloroform is perfectly safe. Next to my fatal case, the most alarming symptoms I ever witnessed from this anesthetic, were in an old man about eighty, with double cataract, upon whom Dr. Friedenwald operated. I gave the chloroform three times in succession, and every time just as sensibility of the cornea was abolished, the man stopped breathing and became cyanotic. By drawing forward the tongue, respiration was re-established each time. After the third interruption, both Dr. Friedenwald and myself concluded that we had better not push the chloroform further. The operation was then done without an anesthetic.

It is a favorite theory with some of the advocates of chloroform, that death is not likely to occur during the stage of complete anesthesia, but before the stage of relaxation comes on. In 219 cases analyzed by Lyman, it appears that the stage at which death occurred was as follows:

Before the full effect of the chloroform - - - -	114
During " " " " " " - - - - -	70
After completion of operation - - - - - -	35
	219

hence it appears that the theory lacks a very essential basis of facts.

The dictum of Sedillot that "pure chloroform properly employed is not dangerous" is not accepted by anyone at the present day, and it is equally irrational to hold with some that ether anesthesia is without danger to the patient. The question of danger is merely a relative one. It is a question of comparative effect.

The manner of death from chloroform has been definitely established by numerous experiments on animals. Clinical observations are in the great majority of cases valueless, for no one who has not stood in the presence of a sudden and unexpected death from this cause can understand the total loss of control of most of those present. It takes an old and experienced surgeon to look on such a death unmoved and retain possession of all his faculties, and to such a one is rarely assigned the duty of administering the anesthetic.

HOW SHOULD ANESTHETICS BE GIVEN?

A general answer would be: always with extreme care, and knowledge of their effects. But I shall try to be more specific, and lay down certain rules which, while largely the result of the experience of others, have been not a little modified by my own observation.

Chloroform or ether should always be given in a large, airy apartment, the temperature of which should not be below 70°.

The administrator should have nothing else to do but to attend to the business he has in hand. The operation itself must not concern him; he must watch the patient's pulse, face and respiration in order to be on guard, should dangerous symptoms arise.

The patient should always be in the recumbent position; all clothing should be loosened around the neck, chest and waist; artificial teeth and corsets must be removed.

The head should not be raised much above the level of the body, and should be turned to one side. This prevents the saliva from flowing into the larynx, and also prevents the tongue falling back, closing the opening of the glottis during complete relaxation.

The anesthetiser must have a pair of strong dressing forceps at hand to draw forward the tongue should that be found neccessary.

The patient should not have any solid food for at least five hours before the operation, and no food whatever for two hours before. Many surgeons give an ounce or two of whiskey or brandy before giving the anesthetic. When chloroform is given, I am inclined to think this is good practice. When ether is used, no other stimulant

should be given. Five to fifteen minutes before beginning the administration of ether I give a hypodermatic injection of from ⅛ to ¼ gr. of morphia to adults. Kappeler in his recent work objects to to this practice, but I have found it to act very pleasantly in reducing the stage of excitement almost to *nil*. It also seems to lessen the tendency to vomiting.

Dr. Reeve of Ohio (*Holmes' System of Surgery, Am. Ed. Article Anesthetics*) advocates the combination of atropia with the morphia before giving the anesthetic. I have had no experience with this, but from the known effect of atropia of stimulating the respiratory centre I am inclined to think it of great value, and shall use it hereafter. The proper dose would be from 1-100 to 1-75 grain in combination with ⅛ to ¼ grain of morphia.

In giving chloroform, I think a towel rolled into a cylinder, on the interior of which the anesthetic is to be poured, is the best form of inhaler. The inhaler should be held at some distance from the patient's face at first, in order that respiratory or cardiac paralysis may not occur from reflex irritation. More than five per cent of chloroform vapor in the inhaled air is dangerous.

The occurence of irregular breathing or irregular action of the heart is the signal for the removal of the inhaler from the face of the patient.

The abolition of sensibility is indicated by the absence of reflex action in the eyelids when the corneal conjunctiva is touched.

When reflex action is abolished, the patient is ready for the operation.

When ether is the anesthetic used, the best and most serviceable inhaler I have seen, is one devised by Dr. Leonard and myself about five years ago.

It consists of a rubber-lined silk or muslin bag, sold in the rubber stores under the name of sponge bag. This is lined on the inside with flannel to furnish a good absorbent surface. The top of the bag has a double draw-string by means of which it can be fastened securely to the face piece or hood. The latter is of india rubber, and is known to the trade as Noyes' hood for nitrous oxide inhalation. By means of the draw-string, the bag is tied to the smaller end of the hood, which must be stiffened by a small ring of tin or other metal, and the inhaler is ready for use.*

*This inhaler can be procured from C. Willms & Co., 79 N. Howard Street Baltimore.

The patient having had a dose of morphia administered hypodermically, and the operator being ready, about two ounces of ether, ("Squibb's stronger ether" only should be used), are poured into the bag. This is immediately absorbed by the flannel and given off as vapor. The patient is then directed to breathe in and out deeply a few times, and just before *expiration* the hood is placed over his mouth and nose, excluding all the air possible. The warm air expired into the bag will raise the temperature of the ether vapor and render it much less irritating to the larynx.

The patient will usually, unless quite intelligent, struggle and try to avoid breathing. The inhaler may then be removed for an instant to allow an inspiration of pure air, but must be immediately reapplied. The patient should be directed calmly to breathe out, "to blow into the bag" for if he expires well, a good inspiration must follow. In three or four minutes, usually, sometimes in two, rarely more than five, the patient will be entirely insensible and ready for any operation.

When the point of total anesthesia is reached, the inhaler should be removed, but reapplied as soon as the slightest evidence of reflex sensibility is manifested by touching the edges of the eyelids.

The secret of success in ether administration is to give it freely. I have seen fourteen ounces of ether wasted without securing anesthesia in a case, and one week later anesthetised the same patient and kept her entirely relaxed for forty-five minutes using only four ounces of the anesthetic. The air should be excluded as much as possible, and the vapor given in a concentrated form. Both these principles are directly contra-indicated in the administration of chloroform.

An incidental advantage of the inhaler just described is that the escape of ether vapor into the room to the discomfort of the surgeon and his assistants is very small. This is one of the great objections to giving ether with any of the "open" inhalers(cone, towels, etc.)

HOW TO AVERT DANGEROUS SYMPTOMS.

Should the tongue drop back on the glottis, attempts should be made to draw it forward with the forceps. This is sometimes impossible. A convenient plan is one recommended by Esmarch and Kappeler. Place the thumbs along the sides of the nose and the fore and index fingers behind the ascending ramus of the lower jaw and draw the latter forward; this opens the glottis.

If the breathing or heart stops, artificial respiration by Sylvester's method should be begun, and kept up until the natural respiratory rhythm is restored, or until all hope of resuscitation should be lost. Patients apparently dead from drowning have been restored after an hour's exertion. Efforts should therefore not be given up too soon. In heart failure, *Nélaton's* method should be resorted to The patient is suspended head downward to allow the blood to reach the brain and stimulate the circulatory centre.

Tracheotomy may be necessary in some cases.

Electro-puncture of the heart should not be attempted, as it is as likely to be hurtful as of use.

Cold sprinkling, or twisting a piece of stiff paper into the nostril or injecting cold water into the nostril, are aids to artificial respiration.

Stimulating inhalations (ammonia) are useless unless inspiration occurs. Injections of brandy or carb. ammonia may be used, though, in my opinion, of questionable utility.

A faradic battery should always be at hand to supplement artificial respiration. Galvanization of the phrenic nerve may be tried; but in the majority of cases it is simpler and equally effective to pass a strong faradic current through the skin at the sides of the nose. The pain produced excites reflex contractions, and a deep inspiration soon follows. Artificial respiration must however not be omitted while these other methods are resorted to.

Hypodermatic injections of brandy, whiskey, ether or liquor ammoniæ are said often to have a rapidly stimulating effect on the pulse and respiration. They should not be omitted when a quickly acting diffusible stimulant is indicated. Inhalations of nitrite of amyl sometimes remove the first indications of weakened circulation and this remedy should always be at hand when chloroform is given.

WHEN SHOULD AN ANESTHETIC BE USED?

The administration of an agent, which suspends for a time the functions of sensation and motion, consciousness and reflex action in the organism; and which, so to speak, brings the subject under its influence to death's door, will naturally not be undertaken by anyone except for good and sufficient reasons. But the question: what constitutes a proper indication for the employment of an anesthetic? is one not so easy to answer in specific terms. While it may be stated in general, that an anesthetic should not be given in any case in which it can be avoided, the limit at which this point of avoidance

should be placed is difficult to lay down. Thus it is unquestionably proper to give an anesthetic in cases where a perfect diagnosis and treatment cannot be accomplished, without such relaxation as can only be obtained under thorough narcotism with one of the vaporous anesthetics. At the same time the mere suppression of pain may be a secondary object altogether in the case. There are other cases however, in which the indications are not so plain. These are cases in which the comfort of the surgeon is involved, and where the administration of the anesthetic is used as a saver of time and discomfort.

I am inclined to interpret the rule laid down more liberally than most authorities. I am of the opinion that the convenience and comfort of the surgeon are as much entitled to consideration as the sensations of the patient, and it is just as proper to anesthetise a patient in order to facilitate the work of the operator, as it is to render the patient unconscious of pain. Of course this presupposes an agent for the production of the anesthesia, which is not in itself highly dangerous to life. If we have not such an agent, I hold that we have morally no right to place the patient's life in extra jeopardy for our own convenience.

I do not hesitate to express the opinion that in ether we have such an agent. That it is absolutely safe, I do not admit; no anesthetic that we at present possess is devoid of danger. But, if properly administered, by a competent person, I hold that the danger is reduced to such a small degree as to justify us in using it in all the cases within the limits I have above attempted to define.